4.6 Wood Treating

This section summarizes Roux Associates' opinion of the present value of costs, as of November 2005, for necessary and appropriate environmental response actions remaining at various wood-treating sites, apportioned to Kerr-McGee based on information that was known or knowable as of November 2005. The total present value for this portfolio of 21 wood-treating sites ranges from $386.9M to $439.1M as provided in the table that follows.

Roux Associates' Present Value Estimates for 2.5(a) Wood-Treating sites			
Site	**Location/Address**	**Low ($M)**	**High ($M)**
Milwaukee, WI	Brown Deer and Granville Roads, at 8716 North Granville Road, Milwaukee, WI	$8.8	$18.2
Sauget, IL	Mile east of the Mississippi River and mile south of I-70, Sauget, IL	$9.1	$12.8
Hattiesburg, MS	Near intersection of US highways 49 and 11, Hattiesburg, MS	$1.6	$2.2
Texarkana, TX	2513 Buchanan Rd. Texarkana, TX	$26.9	$26.9
Rome, NY	Success Drive, Rome Industrial Park, Rome, Oneida County, NY	$4.5	$9.0
Columbus, MS	Site is divided by North 14th Avenue, Columbus, MS	$11.8	$20.6
Toledo, OH	Arco Industrial Park at intersection of Arco Drive and Frenchmen's Road, Toledo, OH	$7.8	$10.2
Beaumont, TX	1110 Pine Street Beaumont, Jefferson County, TX	$8.6	$8.6
Springfield, MO	2800 West High Street in Springfield, MO	$0.9	$3.0
Indianapolis, IN	Former Indianapolis Wood Treating Site- South Sherman Street; Barrington East Property- Iowa Street and Perkins Avenue in Indianapolis, IN	$5.1	$5.1
Mt. Vernon, IL	Mt. Vernon, IL	$3.2	$3.9
Bossier City, LA	600 Hamilton Rd, Bossier City, LA	$9.8	$11.3
Madison, IL	Washington Avenue, south of the city limits of Madison, IL	$3.6	$9.2
Avoca, PA	Rear York Avenue Avoca, PA	$0.3	$0.3
Kansas City, MO	23rd Street and I-435 in the Blue River valley in Kansas City, MO	$1.7	$3.2
Wilmington, NC	North Navassa Road in Navassa, Brunswick County, NC	$43.1	$51.2
Brunswick, GA	Perry Lane in Brunswick, GA	$0.0	$0.0
Meridian, MS	Tommy Web Dr., Meridian, MS	$3.7	$6.3
North Haven, CT	Universal Drive North in North Haven, CT	$0.4	$0.9
Slidell, LA	425 W. Hall Avenue in Slidell, Tammany Parish, LA	$0.0	$0.0
Manville, NJ	Champlain Rd and Main Street in Manville, NJ	$236.0	$236.0
TOTAL		**$386.9**	**$439.1**

9805104

Note that wood treating sites that were not disclosed in Schedule 2.5(a) of the Master Separation Agreement are discussed in **Section 5.1**.

This section provides an overview of Kerr-McGee's wood treating business, the types of chemicals typically associated with contamination originating from wood-treating operations, typical response actions (including presumptive remedies), and associated costs to address such contamination.

Overview of Wood-Treating Processes

In the early 1900s, the commercial wood-treating industry included non-pressure treating and pressure treating processes. Non-pressure wood treating involved coating wooden surfaces with chemical preservatives by brushing, spraying, dipping, or soaking them in wooden tanks. Pressure wood treating involved the injection of preservative into the wood. As described in the *Handbook of Wood Preservation*, pressure-treating processes included:

- Full-cell treatment, which forced preservative into wood thereby giving maximum protection against decay for that depth of penetration; and

- Empty-cell treatment, which aimed to "reduce materially the final retention of preservative, while not reducing the depth of penetration."[1]

In 1906, C.B. Lowry patented an empty-cell wood-treating method used for applying creosote to air-seasoned cross-ties (also commonly known as railroad ties). In 1907 Lowry-type plants were built in Marion, Illinois, Bloomington, Indiana, Springfield, Missouri, Kansas City, Missouri, and Hugo, Oklahoma. The Lowry process involved an initial injection of creosote, followed by applying a quick vacuum to remove excess oil from the timber. The air imprisoned by injecting the oil without a preliminary vacuum expands during the final vacuum, forcing out a certain amount of the oil with it resulting in a net absorption of six to eight pounds per cubic foot.[2]

By 1915, the majority of wood-preserving plants in the United States were using pressure-type processing.[3]

1 American Wood-Preservers' Association, Handbook on Wood Preservation, 1916.
2 American Wood-Preservers' Association, Handbook on Wood Preservation, 1916.
3 American Wood-Preservers' Association, Handbook on Wood Preservation, 1916.

As of 1916, the two leading preservatives used in pressure-treating processes were creosote and zinc chloride, either alone or combined. In 1928, several patents were issued that used pentachlorophenol, which is a crystalline chemical compound (C_6Cl_5OH) and di-, tri-, and polychlorinated phenols for wood-preserving purposes. In 1929, L.P. Curtin patented the use of chlorine derivatives of coal-tar acids of higher molecular weight than the cresols. The production of chlorinated phenols in the United States for wood preserving experiments began circa 1930.[4]

Wood treating operations conducted at Kerr-McGee facilities generally were pressure-type using creosote as the preservative. More specifically, based on discussions with Tronox personnel[5] and Roux Associates' observations during various site inspections[6], Kerr-McGee's wood treating process consisted of the following:

1. The raw wood timbers were typically shipped to a site via railcar. The raw timbers were sorted and processed through a sizer and, depending on the facility, also through an adzing[7] and/or boring mill to cut and shape the wood into product (i.e., railroad ties, poles, etc.).

Timber processing facility at Kerr-McGee's Texarkana Facility

4 Michael H. Freeman, et al., Past, Present, and Future of the Wood Preserving Industry, October 2003, http://fwrc.msstate.edu/pubs/preservation.pdf.

5 Communication with the Tronox Project Manager (Keith Watson) and Tronox site personnel (Richard Allison) on October 11, 2009.

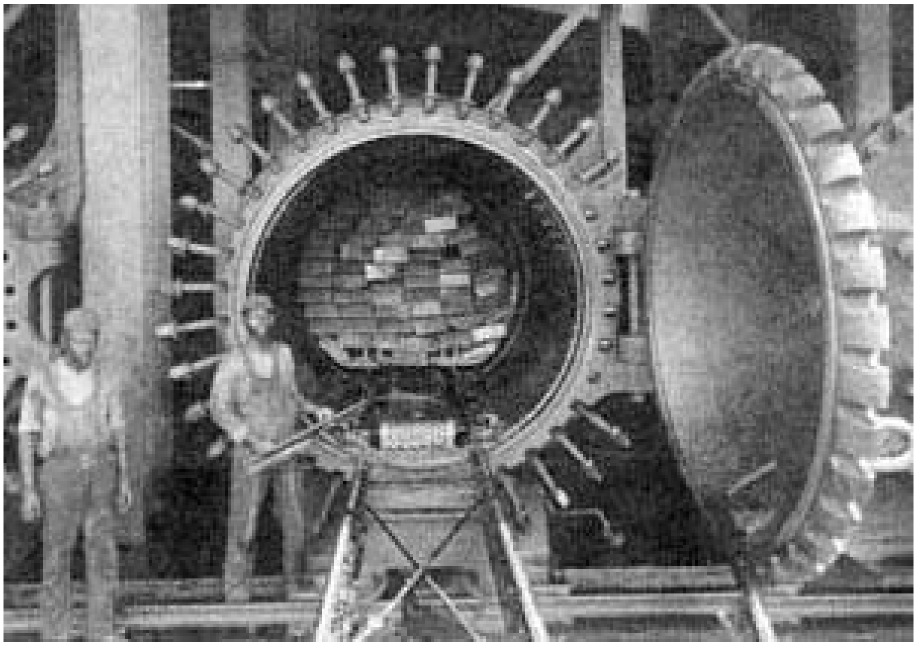
6 Roux Associates conducted site inspections at six former Kerr-McGee wood treating facilities including: Bossier City, LA; Columbus, MS; Meridian, MS; Wilmington, NC; Manville, NJ; and Texarkana, TX. Retorts and other wood handling equipment were present at the Texarkana facility.

7 Adzing is a machine used for wood shaping.

2. After shaping, some facilities installed metal end caps on the untreated ties. Depending on the wood-type, individual facility storage capacity and practices, untreated inventory was stacked outdoors and allowed to weather, sometimes for as long as a year, before treatment.
3. Untreated inventory was placed onto carts or railcars and then loaded into retorts (a cylinder that could be pressurized for treating the wood). Several carts were usually loaded into the cylinder at one time to enable the treatment of hundreds of ties in one session. Preservative was typically stored in ASTs and piped into the retort which was then pressurized. At times heat and vacuum were also applied to remove moisture from the wood. A single treatment session would require several days depending on how the amount of pre-weathering of the untreated wood.

Retorts at Kerr-McGee's Texarkana Site

Open Retort at Kerr-McGee's Texarkana Site



A 1930s photograph showing tie-plant workers loading raw lumber into a treatment cylinder (location and exact date unknown)[8].

Railcar used to move timber (taken at Kerr-McGee Texarkana Site)

4. When treatment was complete, the carts of treated ties would be pulled from the cylinder and staged in the treated wood area of the site where residual creosote was allowed to drip onto the ground. In the 1980s, facilities began installing paved drip pads in an effort to contain some of these drippings. Prior to that, excess preservative from treated ties typically dripped directly to the ground surface.

8 Houston Press Photo Gallery, http://www.houstonpress.com/photoGallery/?gallery=663690&position=4.

Hardened creosote on ground surface at Wilmington, NC site

Hardened creosote at ground surface at Texarkana Site

5. Treated wood was stored in open air, banded together, and typically shipped from the sites by railcar.

As shown in the photograph of the Texarkana site that follows, wood-treating facilities were generally built adjacent to railroad access for the easy delivery and shipment of raw and finished product. A typical facility contained a process area that included a mill, ASTs of preservative, one or more treatment cylinders, and a drip area or pad. The majority of the facilities were used for the storage of stacked untreated and treated storage.

Aerial photograph of the Texarkana wood-treating facility (date unknown).[9]

Wastewater generated from the wood-treating process included a mix of water, sap, and creosote. Historically, wastewater was often discharged via open channels to a nearby surface water body or to an on-site setting pond/lagoon where creosote would separate out and be reused for wood-treating. This practice often resulted in creosote migrating to underlying groundwater.

9 Photograph of the Texarkana facility provided by Tronox, date unknown.

Drainage ditch transporting material from
the Columbus MI wood treating facility to Luxapilila Creek

Kerr-McGee Wood-Forest Division and Wood Treating Operations

In 1904, C.B. Lowry, part owner of a wood-treating plant in Slidell, Louisiana, entered into agreements with the Cleveland, Cincinnati, Chicago & St. Louis Railroad Company for bulk treatment of railroad ties. In 1905, the contract was extended and assigned to the Columbia Creosoting Company which was succeeded by the American Creosoting Company sometime between 1905 and 1908.[10]

In 1918 and 1919, the following wood-treating companies became corporate affiliates of American Creosoting Company: Federal Creosoting Company; Indiana Creosoting Company; Shreveport Creosoting Company; Colonial Creosoting Company; and Georgia Creosoting Company. In June 1919, the companies filed a consolidated federal tax return in the name of "American Creosoting Co. and affiliated corporations" with principal offices at 401 West Main Street, Louisville, Kentucky.[11]

Sometime prior to July 1956, American Creosoting Company acquired two additional subsidiaries, Kettle River Company and Gulf States Creosoting Company. Roux Associates has not located the exact date these companies became subsidiaries of American Creosoting Company.

[10] W.F. Goltra, Some Facts about Treating Railroad Ties, Cleveland, OH: J.B. Savage Company Press, 1912, 43-44.
[11] American Creosoting Co., Inc. v. IRS, 12 B.T.A. 247 (1928).

On July 31, 1956, Union Bag & Paper Corporation purchased the assets of American Creosoting Company, including the stock of the subsidiary companies listed below.

1. Federal Creosoting Company;
2. Indiana Creosoting Company;
3. Colonial Creosoting Company;
4. Georgia Creosoting Company;
5. Georgia Forest Products Company;
6. Kettle River Company; and
7. Gulf States Creosoting Company.[12]

Subsidiaries of American Creosoting Company also operated on leased land at the following locations:

- Hattiesburg, Mississippi (Gulf States Creosoting Company);
- North Haven, Connecticut (American Creosoting Company); and
- Sidney, New York (Federal Creosoting Company).[13,14]

Based on the purchase agreement, the transfer of operations, buildings, equipment, and inventory at these locations was included in the transaction.[15] The purchase of the Sidney, New York plant was announced in the local newspaper which stated, "The Union Bag & Paper Company on Tuesday, August 1, took possession of the Sidney plant of the Federal Creosoting Company."[16]

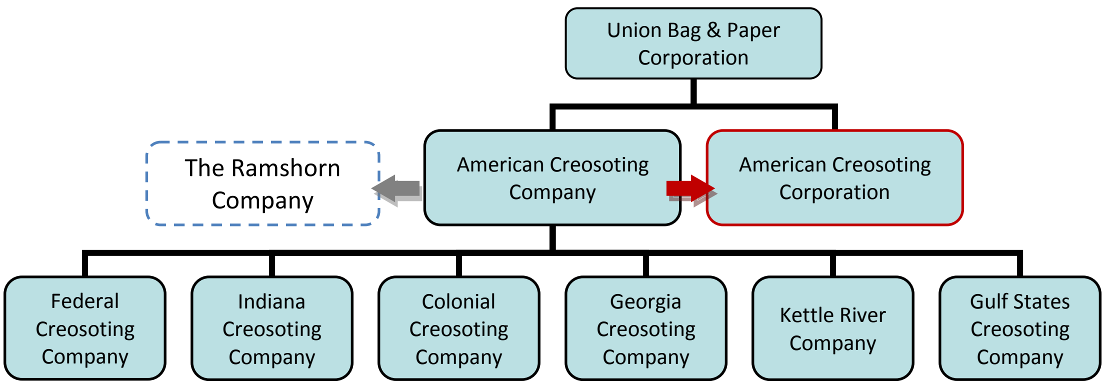
Furthermore, the Federal Creosoting Company facility in Paterson, New Jersey, which ceased operations circa 1952,[17] and the former Shreveport Creosoting Company facility in Shreveport, Louisiana, which ceased operations in 1955,[18] was also transferred during this transaction.

The Sidney, New York, Paterson, New Jersey, and Shreveport, Louisiana wood treating sites were not disclosed in Schedule 2.5(a) of the Master Separation Agreement.

---

12 Union Bag-Camp Paper Corporation, Acquisition of Assets of American Creosoting Company, July 31, 1956.
13 D.B. Frampton & Company, Letter to J.L. Camp, Jr., June 4, 1956 [UCLA02634 – UCLA0235].
14 Union Bag-Camp Paper Corporation, Acquisition of Assets of American Creosoting Company, July 31, 1956.
15 Union Bag-Camp Paper Corporation, Acquisition of Assets of American Creosoting Company, July 31, 1956.
16 Historical newspaper clipping provided by the Sidney Historical Association, Federal Creosoting Sells Sidney Plant, August 2, 1956.
17 Dames & Moore, Environmental Assessment Summary & Site Closure Report, March 2000.
18 Mr. Glen Pile, Adams & Reese, Letter to LDEQ Re: American Creosote DeRidder Site, October 5, 1998.

Union Bag & Paper Corporation assigned the wood treating assets acquired from American Creosoting Company - except for the outstanding shares of stock of Georgia Forest Products Company - to a new wholly-owned subsidiary, American Creosoting Corporation.[19] The outstanding shares of stock of Georgia Forest Products Company and all other (non-wood treating properties) assets were acquired by Union Bag & Paper Corporation.[20] These latter assets remained in the original American Creosoting Company, and this entity was eventually renamed "The Ramshorn Company"[21] (see chart that follows).



Between 1958 and 1960, Gulf States Creosoting Company,[22] Indiana Creosoting Company,[23] Colonial Creosoting Company,[24] Federal Creosoting Company,[25] Georgia Creosoting Company,[26] and Kettle River Company[27] were liquidated and all of their assets and liabilities were transferred to American Creosoting Corporation.

Kerr-McGee Oil Industries, Inc. acquired American Creosoting Corporation in 1964.[28] In April 1965, T.J. Moss Tie Co. (another Kerr-McGee subsidiary with its own portfolio of legacy wood treating sites) was merged into American Creosoting Corporation, which changed its name to

---

19 Memorandum of Transactions, Acquisition of the Assets of American Creosoting Corporation.
20 *Id.*
21 Certificate of Amendment.
22 Gulf States Creosoting Company, Minutes of Special Meeting of the Board of Directors, July 11, 1958.
23 Indiana Creosoting Company, Minutes of Special Meeting of the Board of Directors, November 19, 1958.
24 American Creosoting Corporation, Minutes of Special Meeting of the Board of Directors, November 19, 1958.
25 American Creosoting Corporation, Minutes of Special Meeting of the Board of Directors, December 8, 1959.
26 Georgia Creosoting Corporation, Minutes of Special Meeting of the Board of Directors, December 8, 1959.
27 American Creosoting Corporation, Minutes of Special Meeting of the Board of Directors, December 16, 1960.
28 Certification of Don Hager Regarding the History of American Creosoting Corporation dated April 29, 1999.

Moss American, Inc.[29] In September 1974, Moss American, Inc. was merged into Kerr-McGee Chemical Corporation and Kerr-McGee Chemical Corp. assumed Moss American's obligations.[30] In January 1998, Kerr-McGee Chemical Corporation was merged into Kerr-McGee Chemical LLC.[31]

Environmental Impacts From Wood-Treating Sites

Kerr-McGee's legacy wood-treating sites generally utilized creosote as the preserving chemical. According to ATSDR,[32] creosote preservatives consist of wood creosote ("wood creosote" are creosotes derived from wood such as beechwood), coal tar creosote (derived from the distillation of coal tar) and/or coal tar itself. Of these, coal tar creosote is "the fractions or blends of fractions specifically used for timber preservation," and is referred to as "creosote" by the USEPA. Coal tar creosote has an oily liquid consistency and ranges in color from yellowish-dark green to brown, consisting of aromatic hydrocarbons, anthracene, naphthalene and phenanthrene derivatives.

Similarly, USEPA's "Presumptive Remedies for Soils, Sediments, and Sludges, at Wood Treater Sites" characterizes creosote as an oily, brown to black liquid that is a complex mixture of organic compounds, containing approximately 85% PAHs, 10% phenolic compounds, and 5% nitrogen-, sulfur-, or oxygen-containing heterocyclic compounds.33 Undiluted creosote is denser than water (Specific Gravity equal to 1.07 to 1.08)34 and subsequently migrates vertically downward within an aquifer as a DNAPL.35

---

29 Certification of Don Hager Regarding the History of American Creosoting Corporation dated April 29, 1999; Certificate of Amendment Dated March 29, 1965; Kerr-McGee Oil Industries Board of Directors Meeting Minutes, May 14, 1965

30 Certificate of Ownership and Merger Dated August 16, 1974.

31 Certificate of Merger Dated December 27, 1997.

32 Agency for Toxic Substances and Disease Registry, Toxicological Profile for Wood Creosote, Coal Tar Creosote, Coal Tar, Coal Tar Pitch, and Coal Tar Pitch Volatiles, September 2002.

33 USEPA, Presumptive Remedies for Soils, Sediments, and Sludges, at Wood Treater Sites, EPA/540/R-95/128, December 1995.

34 Agency for Toxic Substances and Disease Registry, Toxicological Profile for Wood Creosote, Coal Tar Creosote, Coal Tar, Coal Tar Pitch, and Coal Tar Pitch Volatiles, September 2002.

35 USEPA, Treatment Technology Performance and cost Data for Remediation of Wood Preserving Sites, EPA/625/R-97/009, October 1997.

Coal tar creosote is typically released to the environment as a result of materials handling of treated timber in stockyard and storage areas. When released to the ground, pure phase creosote, being heavier than water, will migrate downward to the water table, continuing to further migrate downward until reaching a confining layer such as clay or bedrock. Some portion of the creosote will also accumulate on surface soils where it will weather (loss of volatile and biodegradable constituents) and harden over time. Rain water will also mobilize soluble components of residual creosote on surface soils. These soluble fractions will also migrate downward to groundwater. Weathered creosote results when the phenolic and heterocyclic fraction volatilize and the lighter fractions of the PAH constituents degrade.[36]

The creosote release and transport mechanisms noted above are consistent with observations and data at the 21 former wood treating facilities that were included in Schedule 2.5(a) of the Master Separation Agreement. More specifically, non-aqueous phase liquid was detected in 19 of the 21 facilities (90%), often having been found in areas where treated wood was stored and/or in process areas. The two facilities where NAPL has not been detected are as follows:

- **Avoca**: Free product was suspected in a single sampling location in the drip pad area near the treatment building (SB-8). However, no visible product was observed in subsequent sampling in this area or at other areas of the site;
- **Brunswick:** No information about the presence or absence of NAPL was identified in any project documents reviewed by Roux Associates.

Toxicity and Exposure Pathways of Wood Treating Constituents from Wood Treating Facilities

Creosote or coal tar[37] exposure can occur through contact with impacted soil, water and/or air. According to ATSDR, "[i]ndividuals working in the wood-preserving industry make up the largest part of the population that might be exposed to coal tar creosote."[38] When creosote is

36 Agency for Toxic Substances and Disease Registry, Toxicological Profile for Wood Creosote, Coal Tar Creosote, Coal Tar, Coal Tar Pitch, and Coal Tar Pitch Volatiles, September 2002 (http://www.atsdr.cdc.gov/tfacts85.pdf).

37 Creosote is the name used for a variety of products: wood creosote, coal tar creosote, coal tar, coal tar pitch, and coal tar pitch volatiles. These products are mixtures of many chemicals created by high-temperature treatment of beech and other woods, coal, or from the resin of the creosote bush.

38 Agency for Toxic Substances and Disease Registry, Toxicological Profile for Wood Creosote, Coal Tar Creosote, Coal Tar, Coal Tar Pitch, and Coal Tar Pitch Volatiles, September 2002 (http://www.atsdr.cdc.gov/tfacts85.pdf).

present in soils, it can enter the body through the skin or be ingested after putting unwashed hands in the mouth after touching the soil. Exposure may also occur by drinking creosote-contaminated water or eating fish and shellfish from contaminated areas.[39]

Coal tar and creosote contain a group of chemicals known as PAHs that are formed during the incomplete burning of coal and other organic substances. According to USEPA, "The Department of Health and Human Services (DHHS) has determined that some PAHs may reasonably be expected to be carcinogens" and "some people who have breathed or touched mixtures of PAHs and other chemicals for long periods of time have developed cancer."[40] USEPA has classified seven PAHs (benzo[a]pyrene, benzo[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene) as Group B2, probable human carcinogens.[41]

ATSDR reports that brief exposure to large amounts of coal tar creosote can result in the following:

1. Rash or irritation of the skin;
2. Chemical burns of the surfaces of the eye;
3. Convulsions and mental confusion;
4. Kidney or liver problems;
5. Unconsciousness; or
6. Death.[42]

Longer exposure to lower levels of coal tar creosote, coal tar, coal tar pitch, or coal tar pitch volatiles by direct contact with the skin or by exposure to the vapor from these mixtures can result in the following:

- Increased sensitivity to sunlight;
- Damage to the cornea; and
- Skin damage (reddening, blistering, peeling).[43]

---

[39] Agency for Toxic Substances and Disease Registry, Toxicological Profile for Wood Creosote, Coal Tar Creosote, Coal Tar, Coal Tar Pitch, and Coal Tar Pitch Volatiles, September 2002 (http://www.atsdr.cdc.gov/tfacts85.pdf).
[40] Agency for Toxic Substances and Disease Registry, Toxicological Profile for Polycyclic Aromatic Hydrocarbons (PAHs), September 1996 (http://www.atsdr.cdc.gov/tfacts69.pdf).
[41] http://www.epa.gov/ttn/atw/hlthef/polycycl.html.
[42] Agency for Toxic Substances and Disease Registry, Toxicological Profile for Wood Creosote, Coal Tar Creosote, Coal Tar, Coal Tar Pitch, and Coal Tar Pitch Volatiles, September 2002 (http://www.atsdr.cdc.gov/tfacts85.pdf).

Long-term contact with creosote "has been associated with increased risk of contracting cancer." Specifically, "[l]ong-term exposure to low levels of creosote, especially direct contact with the skin during wood treatment or manufacture of coal tar creosote-treated products, has resulted in skin cancer and cancer of the scrotum."[44] Also, "longer exposures to the vapors of creosote, coal tar, coal tar pitch, or coal tar pitch volatiles can cause irritation of the respiratory tract."[45] According to ATSDR, the "International Agency for Research on Cancer (IARC) has determined that coal tar is carcinogenic to humans and that creosote is probably carcinogenic to humans" and the "EPA has determined that coal tar creosote is a probable human carcinogen."[46]

Remedial Actions for Wood-Treating Sites

As discussed within the sections for the individual sites within the Kerr-McGee legacy wood treating portfolio, Kerr-McGee utilized one or more of the following remedial actions to address creosote contamination at their sites:

1. Excavation of grossly contaminated soils;
2. Recovery of pure-phase NAPL (liquid creosote);
3. Capping (including geosynthetic liners);
4. Slurry walls and sheet piling (for plume containment);
5. Bioremediation (including monitored natural attenuation)
6. Phytoremediation (used for hydraulic control);
7. Chemical oxidation;
8. Geotubes (for sediment dewatering)
9. Free product recovery (hand bailing and active recovery);
10. Groundwater recovery and treatment (including a variety of recovery systems such as well points and interceptor trenches); and/or
11. Deed Restrictions.

---

43 Agency for Toxic Substances and Disease Registry, Toxicological Profile for Wood Creosote, Coal Tar Creosote, Coal Tar, Coal Tar Pitch, and Coal Tar Pitch Volatiles, September 2002 (http://www.atsdr.cdc.gov/tfacts85.pdf).

44 Agency for Toxic Substances and Disease Registry, Toxicological Profile for Wood Creosote, Coal Tar Creosote, Coal Tar, Coal Tar Pitch, and Coal Tar Pitch Volatiles, September 2002 (http://www.atsdr.cdc.gov/tfacts85.pdf).

45 Agency for Toxic Substances and Disease Registry, Toxicological Profile for Wood Creosote, Coal Tar Creosote, Coal Tar, Coal Tar Pitch, and Coal Tar Pitch Volatiles, September 2002 (http://www.atsdr.cdc.gov/tfacts85.pdf).

46 Agency for Toxic Substances and Disease Registry, Toxicological Profile for Wood Creosote, Coal Tar Creosote, Coal Tar, Coal Tar Pitch, and Coal Tar Pitch Volatiles, September 2002 (http://www.atsdr.cdc.gov/tfacts85.pdf).

NAPL recovery systems were installed at thirteen of the twenty-one (62%) wood treating sites included in schedule 2.5(a) of the Master Separation Agreement. The 8 sites where NAPL systems were not installed and associated comments are provided in the table that follows.

Former Wood Treating Facilities Where NAPL Recovery Systems Were Not Installed	
Site	**Comment**
Avoca	No NAPL detected.
Bossier City	Investigation identified the presence of weathered creosote in soil; however, the extent of NAPL has not been evaluated and work has not yet progressed to the remedial action phase at this site.
Brunswick	No information about the presence or absence of NAPL was identified in any project documents reviewed by Roux Associates.
Manville	Technical Impracticability Waiver granted for DNAPL in bedrock.
Meridian	No information about the presence or absence of NAPL was identified in any project documents reviewed by Roux Associates.
Mount Vernon	Investigation identified the presence of NAPL. There has been no NAPL remediation based on project documents reviewed by Roux Associates.
Toledo	Work has not yet progressed to the remedial action phase.
Wilmington	Work has not yet progressed to the remedial action phase.

The NAPL recovery systems at the 13 Kerr-McGee sites are consistent with USEPA's presumptive remedy, where appropriate, for addressing NAPL in groundwater at wood treating sites,[47] as summarized below, along with other presumptive remedies at wood treating sites:

- *NAPL:* (1) "utilize a pump-and-treat system to treat the groundwater and any NAPL that is recovered with the groundwater; and (2) install hydraulic containment to contain any remaining NAPL." Free-product recovery may also be added if NAPL is of sufficient thickness;
- *Groundwater:* traditional pump-and-treat technologies such as carbon adsorption; and
- *Soils, Sediments, and Sludges:* Treatment of excavated soil/sediment/sludges by bio-remediation, thermal desorption, and incineration.

[47] USEPA, Treatment Technology Performance and cost Data for Remediation of Wood Preserving Sites, EPA/625/R-97/009, October 1997.

Basis of Roux Associates' Cost Estimate for Wood Treating Sites

Sections 4.6.1 through **4.6.21** provide detailed discussions about the 21 wood-treating sites that were disclosed in Schedule 2.5a of the Master Separation Agreement including Roux Associates' opinion of the present value of costs, as of November 2005, for necessary and appropriate environmental response actions remaining at various wood-treating sites, apportioned to Kerr-McGee based on information that was known or knowable as of November 2005. For sites where sufficient site-specific information was available, Roux Associates estimated the present value of costs using specific cost information provided in site documents or using RACER™ to estimate identified assessment and/or remediation tasks based upon future projected work. Where site-specific costs were unavailable, Roux Associates utilized the average total present value of project life cycle costs based upon the portfolio of environmental legacy wood-treating sites that were disclosed in Schedule 2.5(a) of the Master Separation Agreement.

In addition, for several sites where site-specific costs were unavailable, Roux Associates utilized estimated costs to conduct an RI/FS, RD, and RA provided in a report to Congress entitled, "Superfund's Future: What will it cost?"[48] According to this document, the cost to conduct an RI/FS, RD, and RA at a wood-treating site (in 1999 dollars) was $750,000, $1,000,000, and $11,000,000, respectively.

Adjusting the combined total of $12,750,000 using an inflation factor derived from the Implicit Price Deflator for Gross National Product (GNP) provides an inflation factor of 1.152 between 1999 and 2005. The 1.152 value is equal to the Gross Domestic Product (GDP) Implicit Price Deflator factors published by the U.S. Department of Commerce, Bureau of Economic Analysis,[49] equal to the 99.99 (for 2005) divided by 86.75 (for 1999). Therefore, the cost to conduct a RI/FS, RD, and RA at a wood treating site is equal to **$14,688,000** (equal to 1.152 * $12,750,000). Note that this method for adjusting for past inflation is allowed by the USEPA to annually update closure cost estimates for RCRA-licensed hazardous waste management facilities (40 CFR 264.142[b]) with respect to inflation.

48 K. Probst and D. Konisky, Superfund's Future: What Will it Cost": A Report to Congress, Resources for the Future, Washington, DC, ISBN 1-891853-39-22001.

49 www.bea.gov/.

Individual costs for conducting an RI and/or FS separately were not provided; however, based on Roux Associates' professional experience, the cost of the RI phase typically constitutes about 75% of total RI/FS costs. Individual estimated costs for conducting an RI and/or FS were calculated using this assumption. These wood-treating site costs are summarized below:

RI/FS, RD, and RA costs based on "Superfund's Future: What will it cost?"		
Task	**1999 Cost**	**2005 Cost (Adjusted)**
RI (only)	$562,500	$648,000
FS (only)	$187,500	$216,000
RI/FS (combined)	$750,000	$864,000
RD	$1,000,000	$1,152,000
RA	$11,000,000	$12,672,000
Total RI/FS, RD, RA	**$12,750,000**	**$14,688,000**

Further, for sites where site-specific costs were unavailable or could not be estimated using RACER™, Roux Associates estimated the total present value of life cycle costs for such sites based upon estimated life cycle costs determined from those sites were site-specific costs were available and/or could be derived. More specifically, Roux Associates categorized sites into one of three categories (A, B or C) based upon site characteristics and impacts requiring remediation and then developed the total present value of life cycle costs, summarized in **Table 4-6a**, based upon:

- Actual costs incurred by Kerr-McGee through 2005[50] adjusted for Kerr-McGee's proportion of costs; and
- Roux Associates' estimated present value of costs to conduct additional necessary and appropriate response actions after 2005.

Results of this analysis are summarized in the text box that follows.

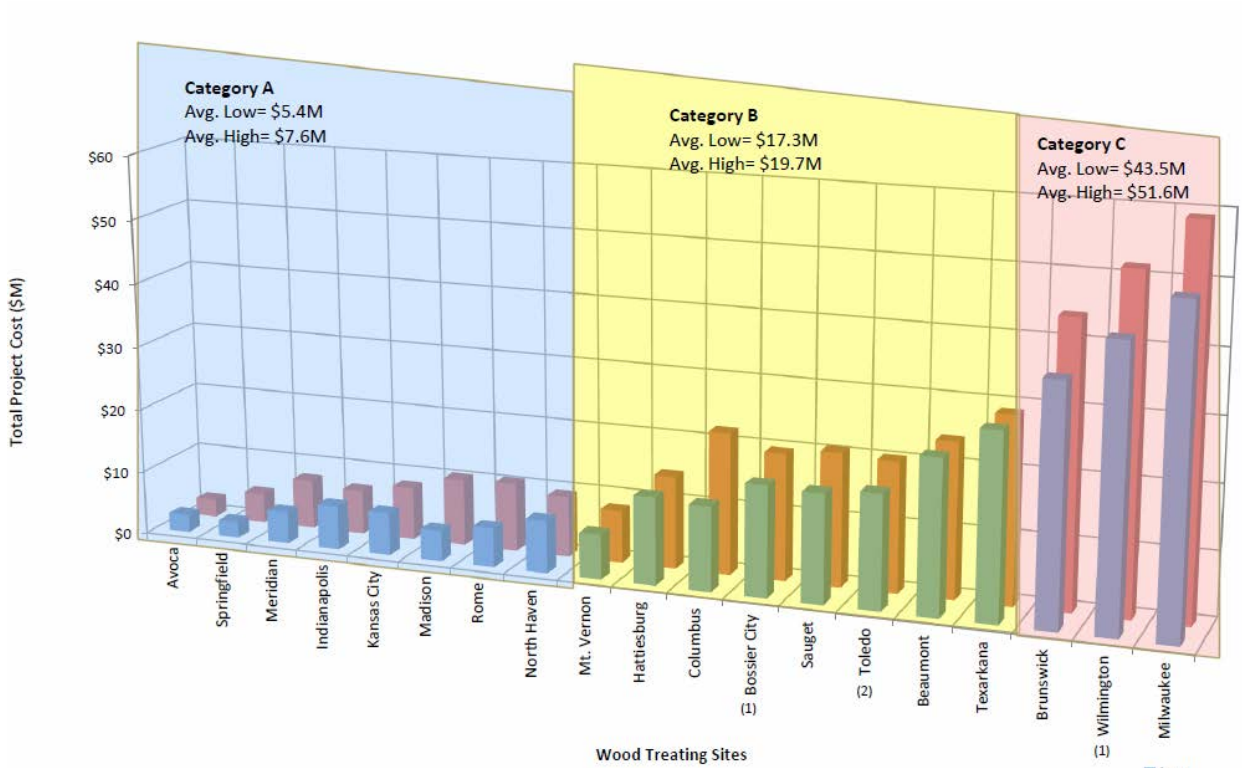
[50] Expenditures from project inception through 2005 were taken from the undated spreadsheet titled "Tronox Environmental Legacy Spend" provided by Tronox. This spreadsheet lists Kerr-McGee/Tronox expenditures on an annual basis from pre-1997 through 2007, and thus, for the purposes of evaluating past project expenditures as of November 2005, contains information that was known to Kerr-McGee in November 2005.

Average Total Present Value of Project Life Cycle Range for Wood-treating Sites Included in Schedule 2.5(a)			
Site Category	**Site Characteristics**	**Average Present Value of Project Cost Ranges (in $M rounded to nearest $100K)**	
		Low	**High**
Category A (8 sites) Avoca, Springfield, Meridian, Indianapolis, Kansas City, Madison, Rome North Haven	Sites with smaller scale assessment and/or remediation; Limited or no offsite impacts requiring remediation	$5.4M	$7.6M
Category B (8 sites) Mount Vernon, Hattiesburg, Columbus, Sauget, Bossier City, Toledo, Beaumont, Texarkana	Sites with larger scale assessment and/or remediation; All requiring offsite remediation	$17.3M	$19.7M
Category C (3 sites) Brunswick, Wilmington, Milwaukee	Complex onsite and/or offsite remediation	$43.5M	$51.6M

*Average calculated by summing all values in each grouping (low and high values), divided by total data population
**Because costs at the Manville and Slidell sites exceeded the Category C metric by more than $100M, present values of the costs for these sites were not included in the life-cycle average calculations.
**Further, the Slidell site is not included in the life-cycle present value averages because Kerr-McGee reached a settlement with the USEPA and LDEQ which did not reflect total project costs.

This information is further illustrated in the figure that follows.

Range in Present Value of Total Project Costs for 2.5(a) Category A, B and C Sites



Notes:
(1) = Roux used a component of the average life-cycle costs for Category A, B, or C to calculate estimate of future costs post 2005
(2) Toledo=Average B life-cycle high/low costs+ $535,000 for EPA reimbursment

Note that the categories above exclude the Manville and Slidell wood treating sites because:

- Lifecycle at the Manville, New Jersey site exceeded the Category C sites by more than $200M.
- At the Slidell site, in fall 1996, Kerr-McGee entered into Consent Decrees with the USEPA[51] and LDEQ[52] for the sums of $20 million and $1.5 million dollars respectively for Kerr-McGee's share of the reimbursement of both past and future costs, assuming that future site conditions would remain unchanged. Expenditures through 2006 totaled approximately $136M.[53]
- If total life cycle costs[54] for Manville ($296.3M[55]) and Slidell ($136M) were included in Category C, the metric for Category C sites would increase to approximately $132M.

---

[51] United States District Court for the Eastern District of Louisiana, Civil Action No. 96-0872, Section E. Mag. 3 (TRX-EED-00538630-00538656).

[52] United States District Court for the Eastern District of Louisiana, Civil Action No. 96-0862, Section S. Mag. 3 (no bates).

[53] See **Section 4.6.20** for Roux Associates' calculation of costs incurred through 2006 at the Slidell site.

[54] These lifecycle costs are conservative, as they only include costs incurred through 2006 for the Slidell site and costs incurred through 2009 for the Manville site.

Cost Apportionment at Wood-treating Sites Disclosed in Schedule 2.5(a)

Roux Associates apportioned the present value of costs for each of the wood treating sites (detailed in **Sections 4.6.1** through **4.6.21**) based upon the following factors:

- 100% apportioned to Kerr-McGee if Kerr-McGee was the sole entity that conducted wood treating operations at the site (i.e. "sole operator");
- 100% apportioned to Kerr-McGee at certain sites where other entities also conducted wood treating operations where Kerr-McGee was the sole performing PRP; and
- Kerr-McGee was apportioned less than 100% at other sites because: (a) Kerr-McGee had established a participation/cost sharing agreements between applicable entities or (b) apportionment agreements had been established by USEPA and/or State regulatory agencies.

The table that follows summarizes the apportionment for the wood treating sites disclosed in Schedule 2.5(a) of the Master Separation Agreement.

Apportionment between Former Operators	
Site	**Apportionment Assigned by Roux Associates**
Milwaukee, WI	100% (sole operator)
Sauget, IL	100% (sole performing PRP)
Hattiesburg, MS	100% (sole operator)
Texarkana, TX	100% (sole performing PRP)
Rome, NY	100% (per Voluntary Cleanup Agreement)
Columbus, MS	100% (sole performing PRP)
Toldeo, OH	100% (per Unilateral Administrative Order)
Beaumont, TX	100% (per Administrative Order)
Springfield, MO	100% (sole operator)
Indianapolis, IN	100% (sole operator)
Mt. Vernon, IL	56% (per Participation Agreement)
Bossier City, LA	65% (per Cost Sharing Agreement)
Madison, IL	100% (sole operator)
Avoca, PA	100% (sole operator)
Kansas City, MO	100% (sole operator)
Wilmington, NC	100% (sole operator)
Brunswick, GA	$345,000 (per USEPA Agreement)
Meridian, MS	100% (sole operator)
North Haven, CT	40% (per Settlement Agreement)
Slidell, LA	$1.5M (per LADEQ Settlement), $20M (per USEPA settlement)
Manville, NJ	100% reimbursement sought from Kerr-McGee by USEPA

[55] USEPA SCORPIOS Database. Federal Creosote Site, Manville, NJ Cost Recovery Package #1-#4. All costs through 04/30/2009 (PPO7/FY05- PP14/FY09). Report dates 06/26/2009 and 08/11/2009.

Wood Treating Insurance Policy

In 2000, Kerr-McGee Corporation purchased a $100M combined single limit pollution legal liability and cost cap insurance policy from AIG for the following six wood treating sites in their Forest Product Division:

- Madison, Illinois;
- Springfield, Illinois;
- Texarkana, Texas;
- The Dalles, Oregon;
- Indianapolis, Indiana; and
- Columbus, Mississippi.[56]

The policy term covers pre-existing conditions from December 31, 2000 through December 31, 2010.[57] According to Tronox, claims have been submitted; however Tronox has not received reimbursement under the policy because the self insured retention limits have not been met.[58] Roux Associates has not included the impacts of insurance coverage in its analysis as it is being included as a contingent asset in the solvency analysis of the Trust's solvency expert.

The subsections that follow provide site-specific information and cost projections for each of the wood-treating sites discussed in the preceding sections.

---

56 Commerce & Industry Insurance Company (AIG), Pollution Legal Liability and Cost Cap Insurance, Forest Products Division, Policy Number PLS/CCC 5295422, Pre-Existing Conditions Policy Term: December 31, 2000 to December 31, 2010.

57 Commerce & Industry Insurance Company (AIG), Pollution Legal Liability and Cost Cap Insurance, Forest Products Division, Policy Number PLS/CCC 5295422, Pre-Existing Conditions Policy Term: December 31, 2000 to December 31, 2010.

58 Personal communication with Matt Paque of Tronox, December 21, 2010.